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Larsen et al.

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[54] **CRUISE CONTROL SYSTEM FOR A VEHICLE**

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5,168,970 12/1992 Hough et al. 180/307
5,228,360 7/1993 Johnson 74/512

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[57] **ABSTRACT**

[21] Appl. No.: **09/040,625**

A cruise control system for a vehicle comprises an accelerator linkage that is linked to the input lever of a variable speed transmission. The accelerator linkage is biased to neutral, but can be moved against the bias by an operator who pushes down on an accelerator. A cruise control link which is separate from the accelerator linkage has one end coupled to the accelerator linkage by a pin and slot connection. The cruise control link can be locked in a fixed position by an electromagnet that can be selectively energized by the operator. A spring normally keeps the pin on the cruise control link in engagement with a forward end of the slot carried on the accelerator linkage to prevent the accelerator linkage from returning to neutral when the cruise control link is locked in place by the electromagnet. However, the operator can temporarily increase the vehicle speed since additional forward movement of the accelerator linkage is permitted by the length of the slot. This additional forward movement of the accelerator linkage does not lose or destroy the current fixed setting of the cruise control link.

[22] Filed: **Mar. 18, 1998**

Related U.S. Application Data

[62] Division of application No. 09/024,172, Feb. 17, 1998.

[51] **Int. Cl.**⁶ **B60K 31/02**

[52] **U.S. Cl.** **180/170; 180/178**

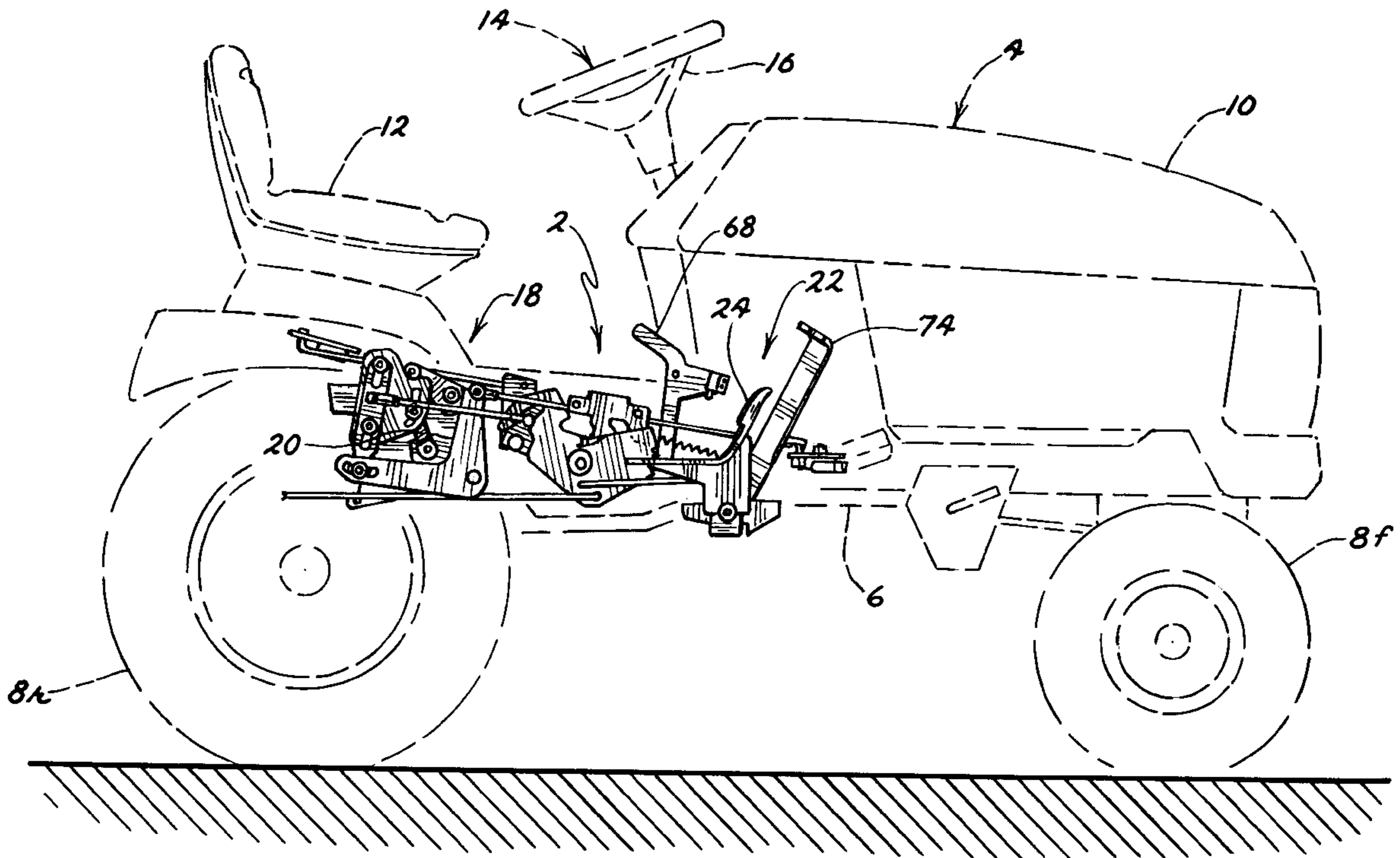
[58] **Field of Search** 180/170, 272,
180/174, 177, 178, 307; 74/512, 513, 526;
123/340, 350, 102

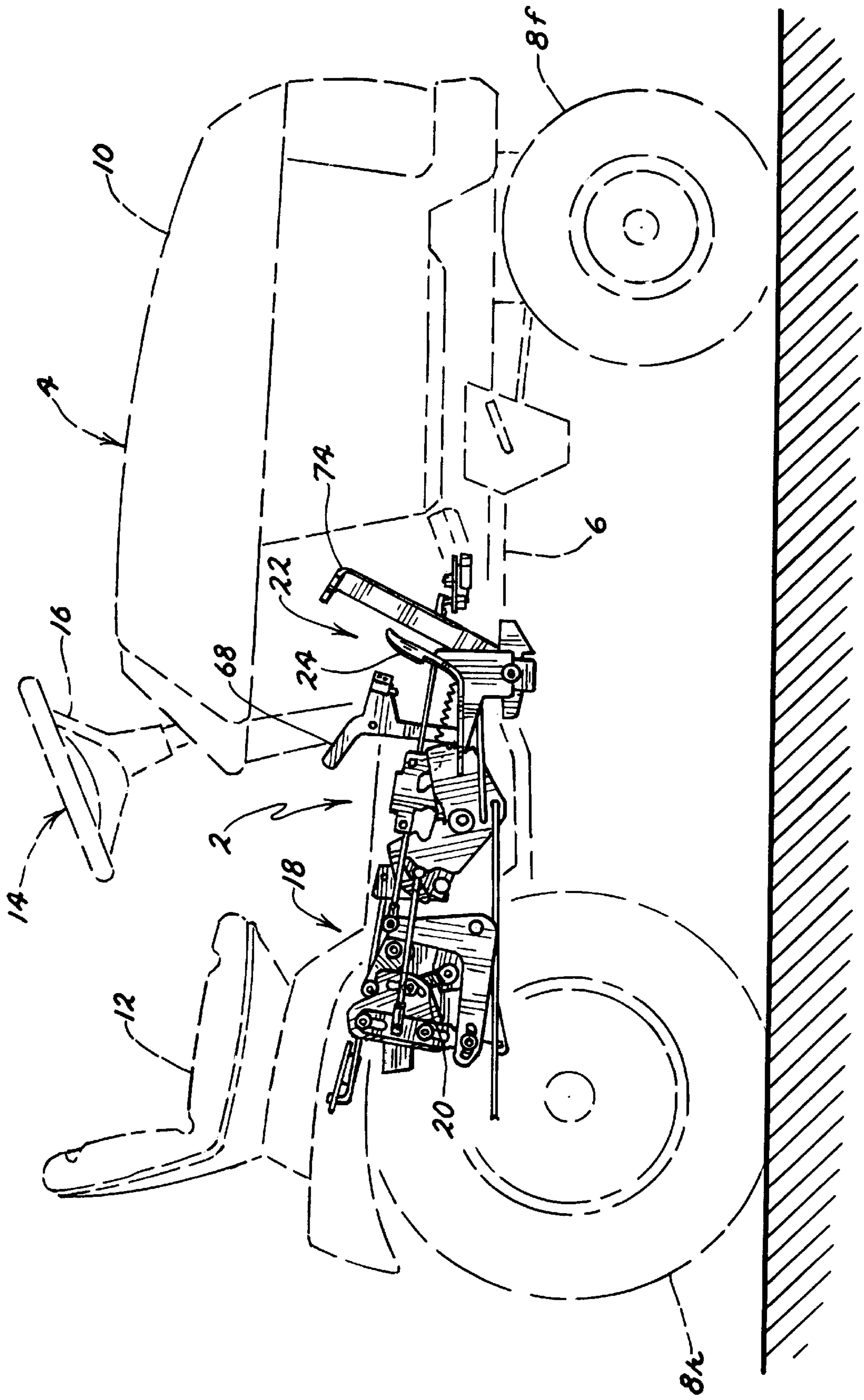
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12 Claims, 8 Drawing Sheets





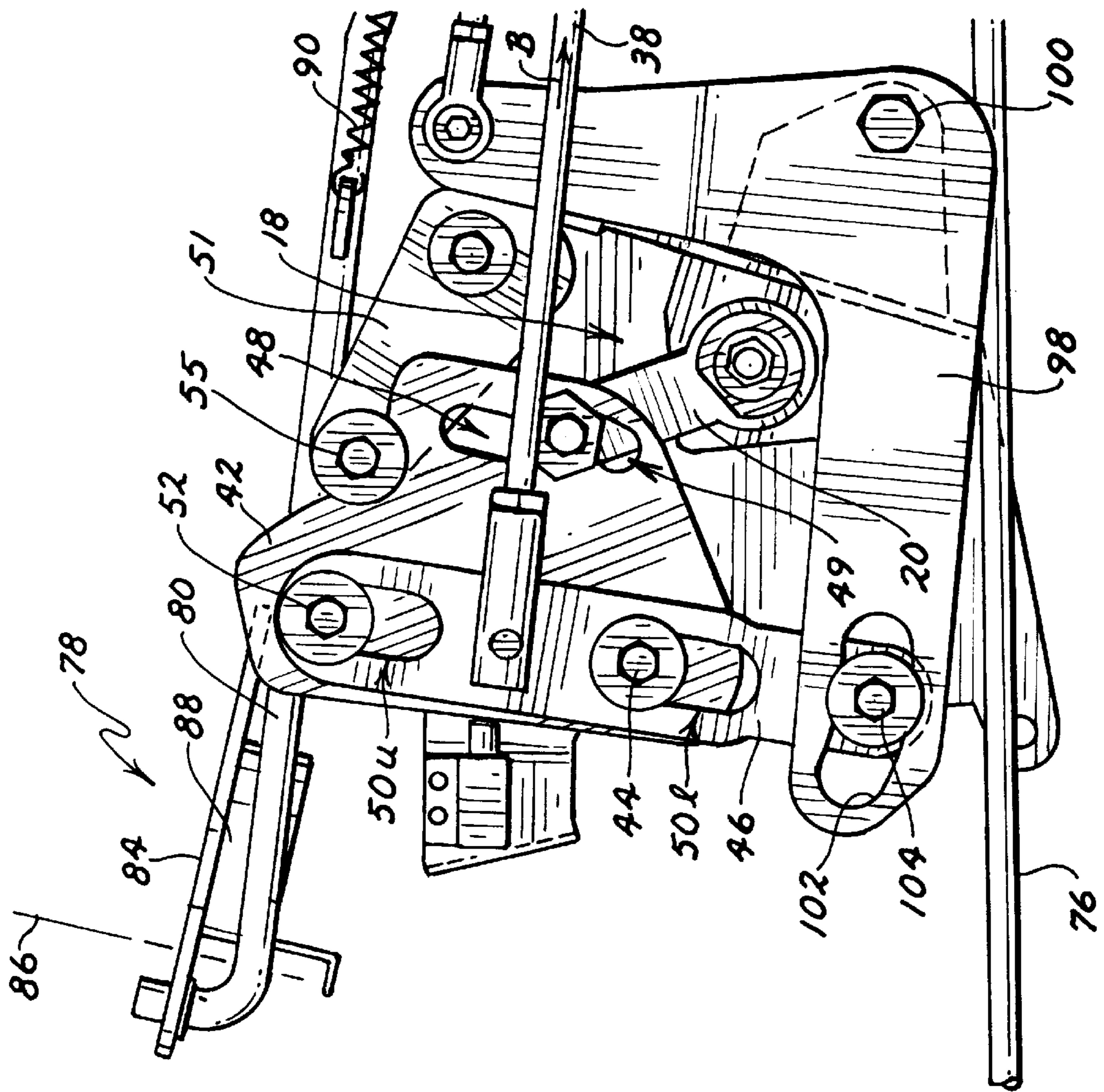


FIG. 2A

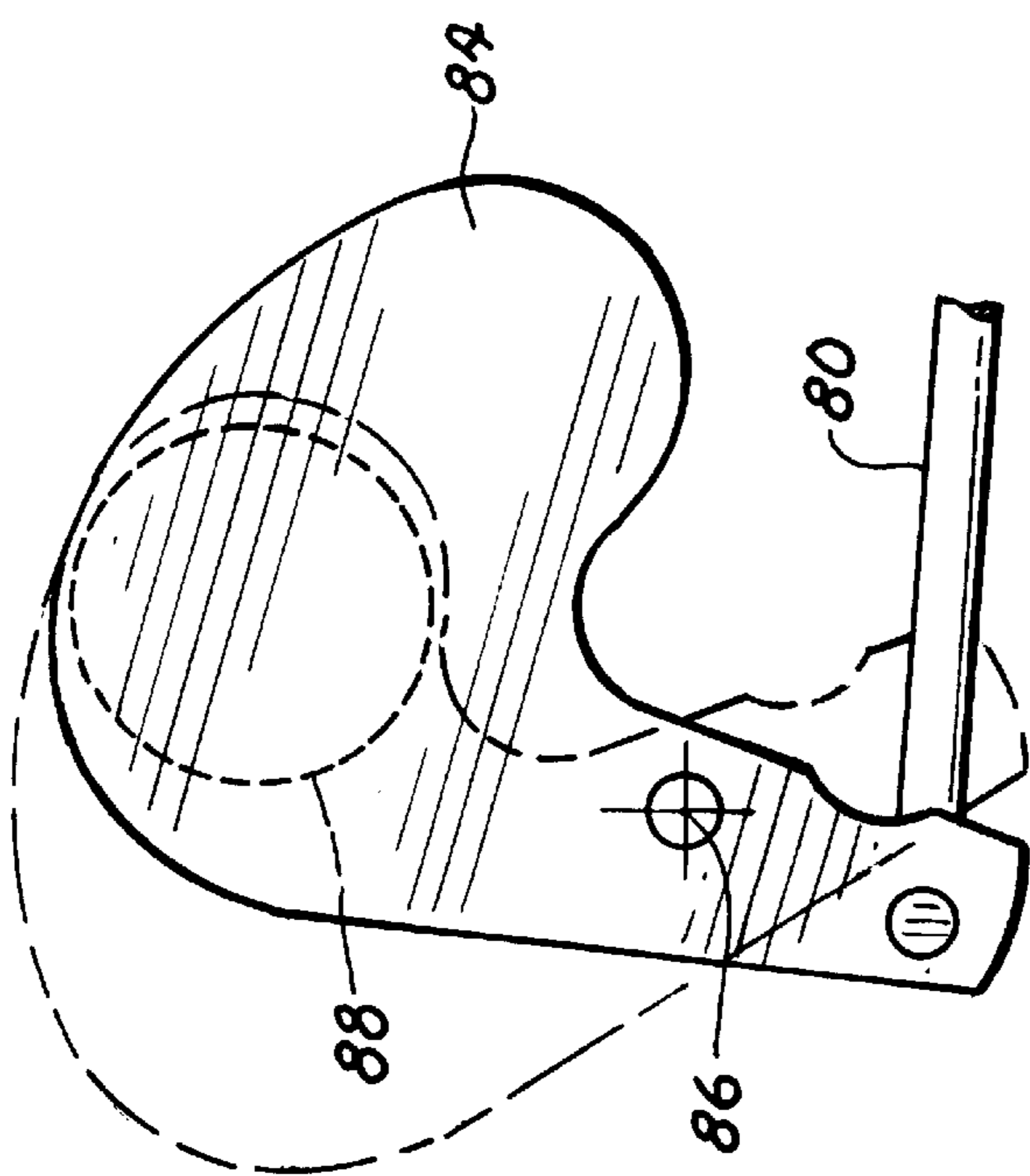


FIG. 2B

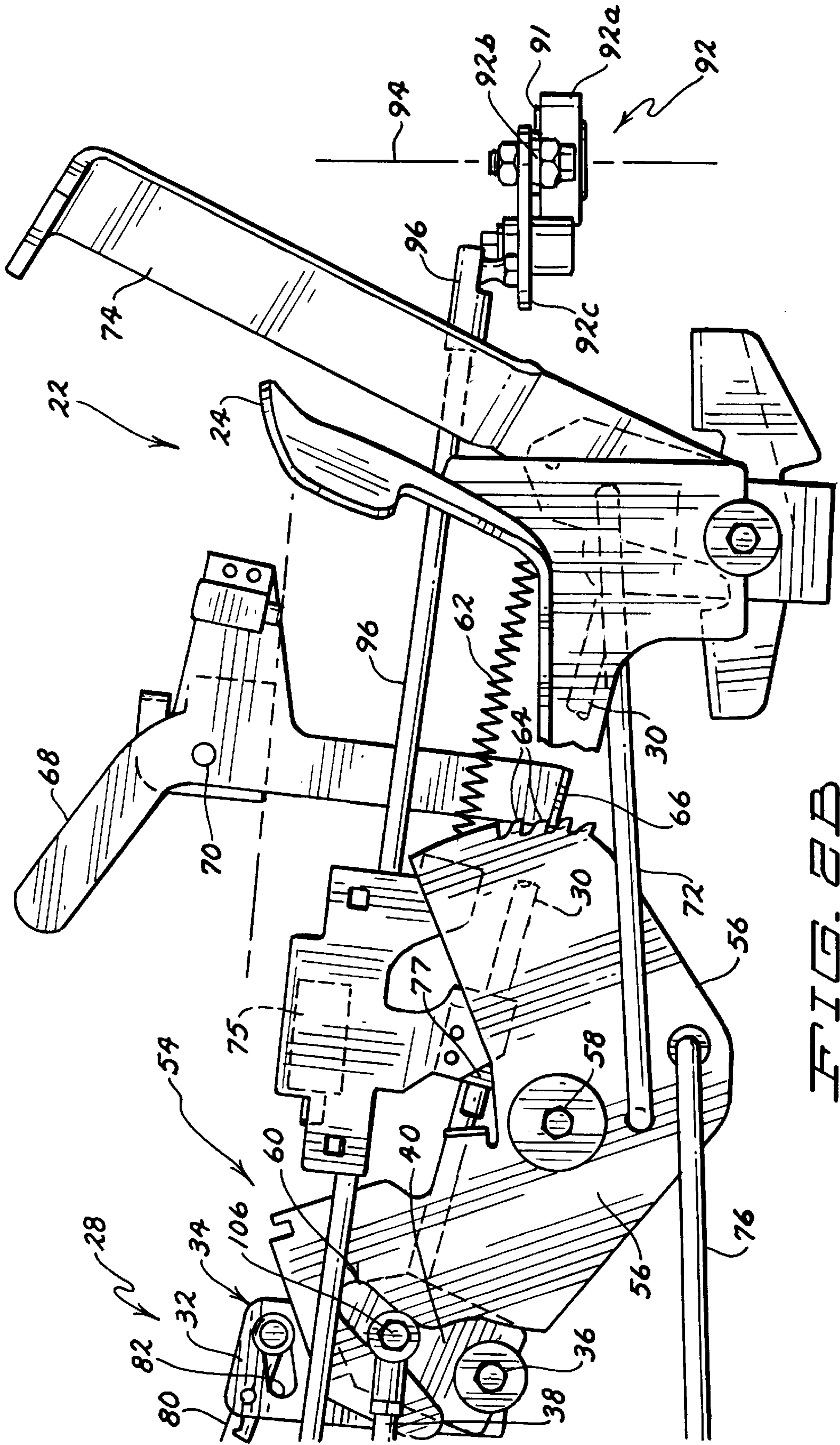


FIG. 2B

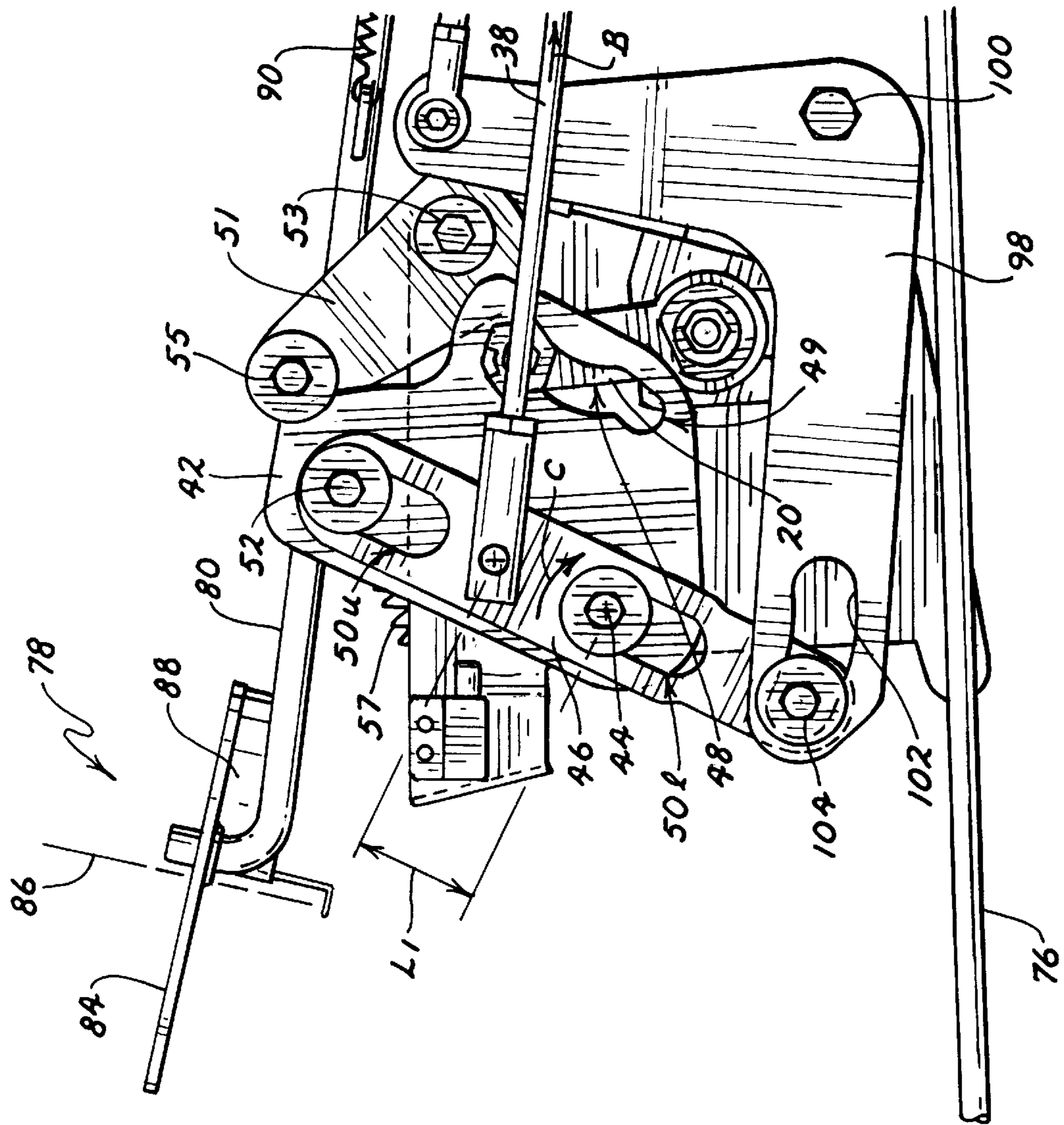


FIG. 4A

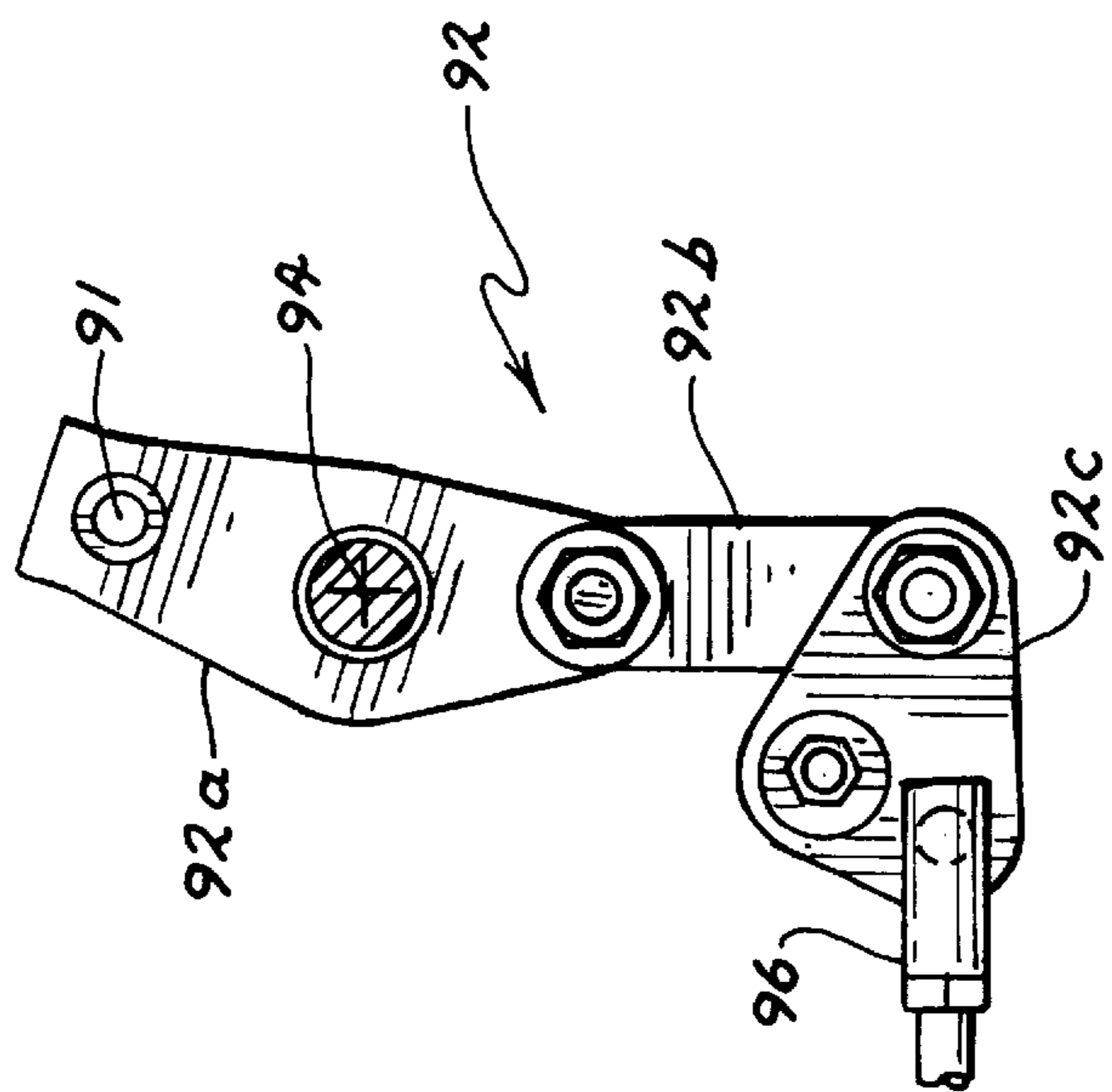


FIG. 5

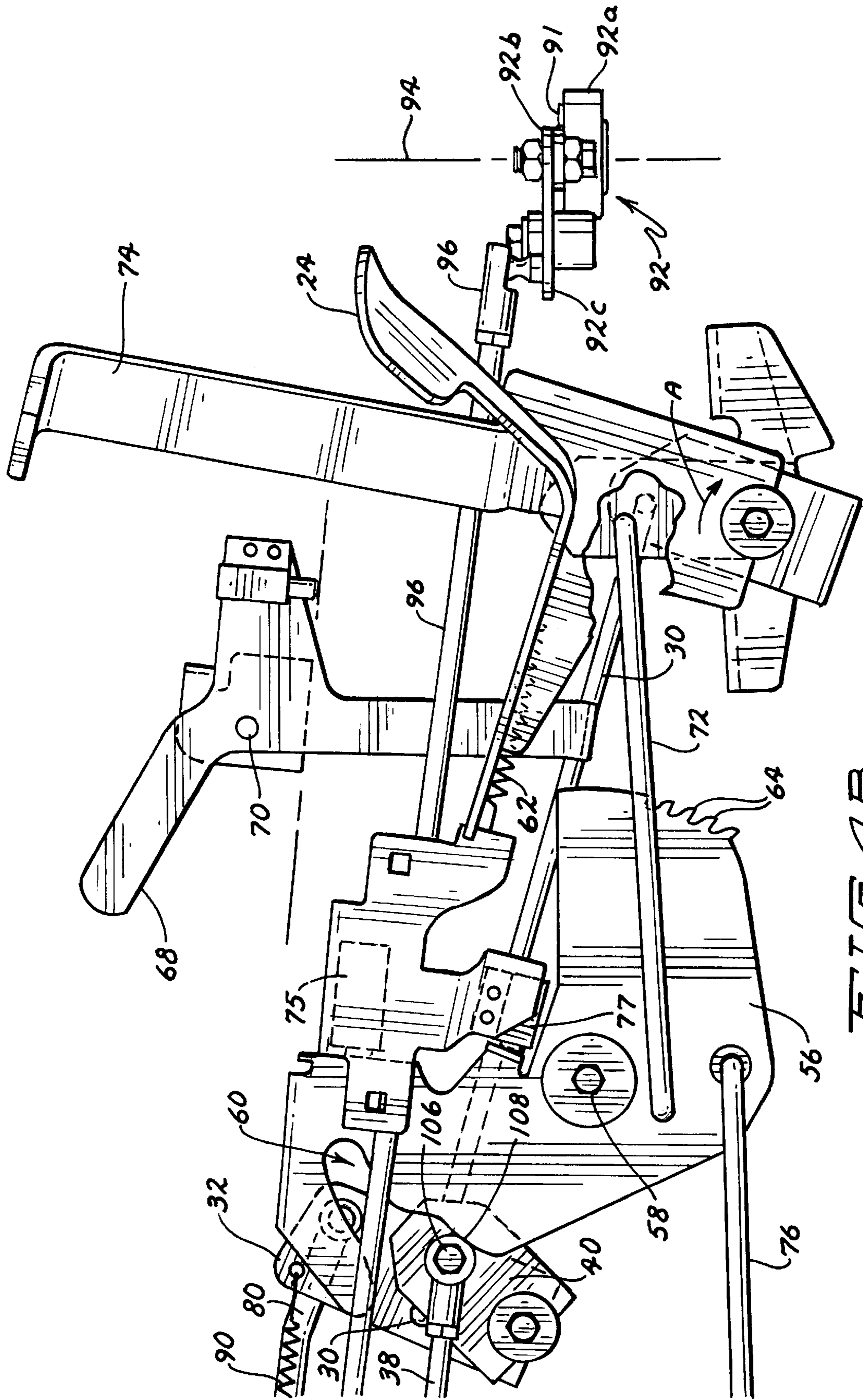


FIG. 4B

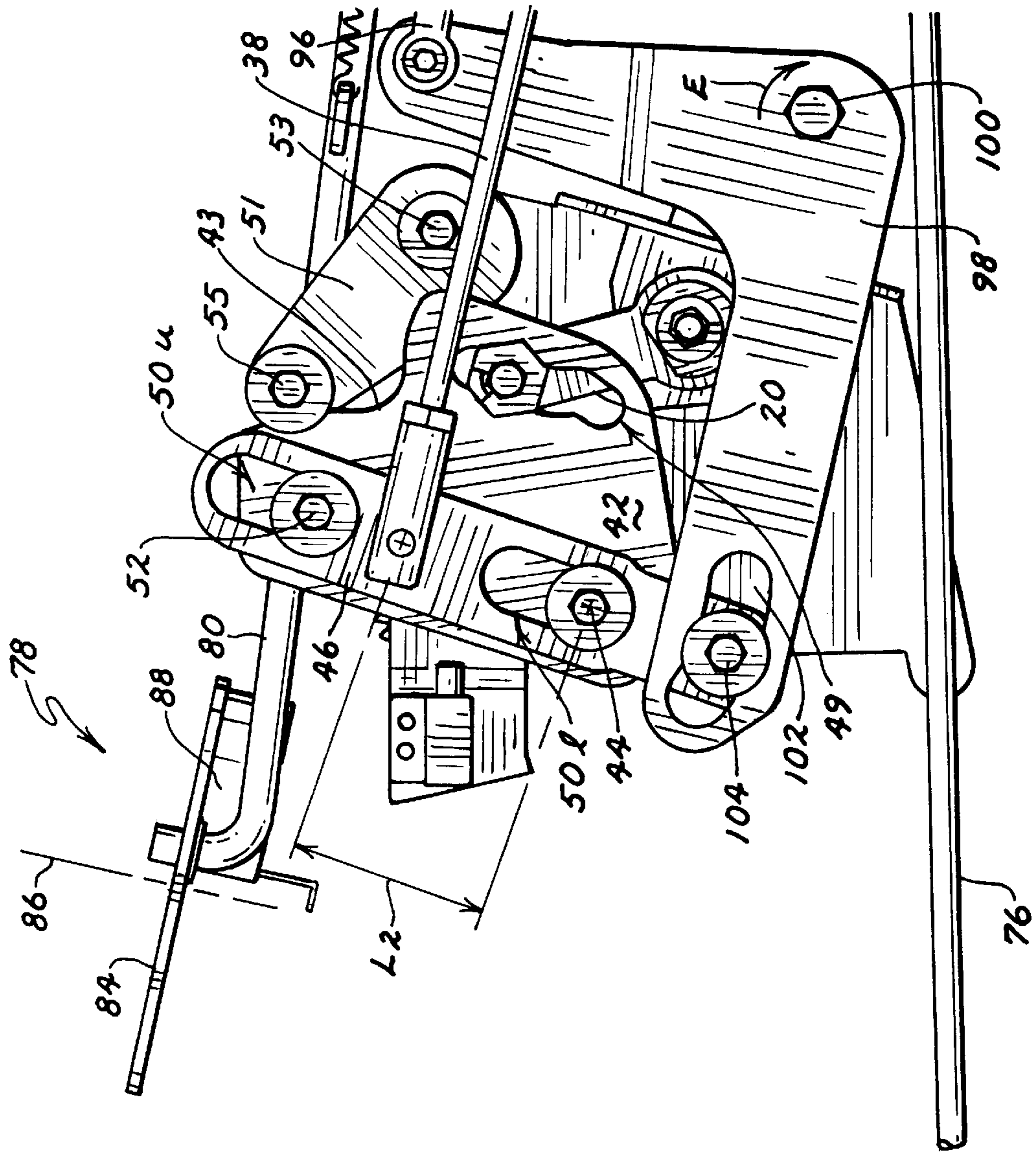


FIG. 7

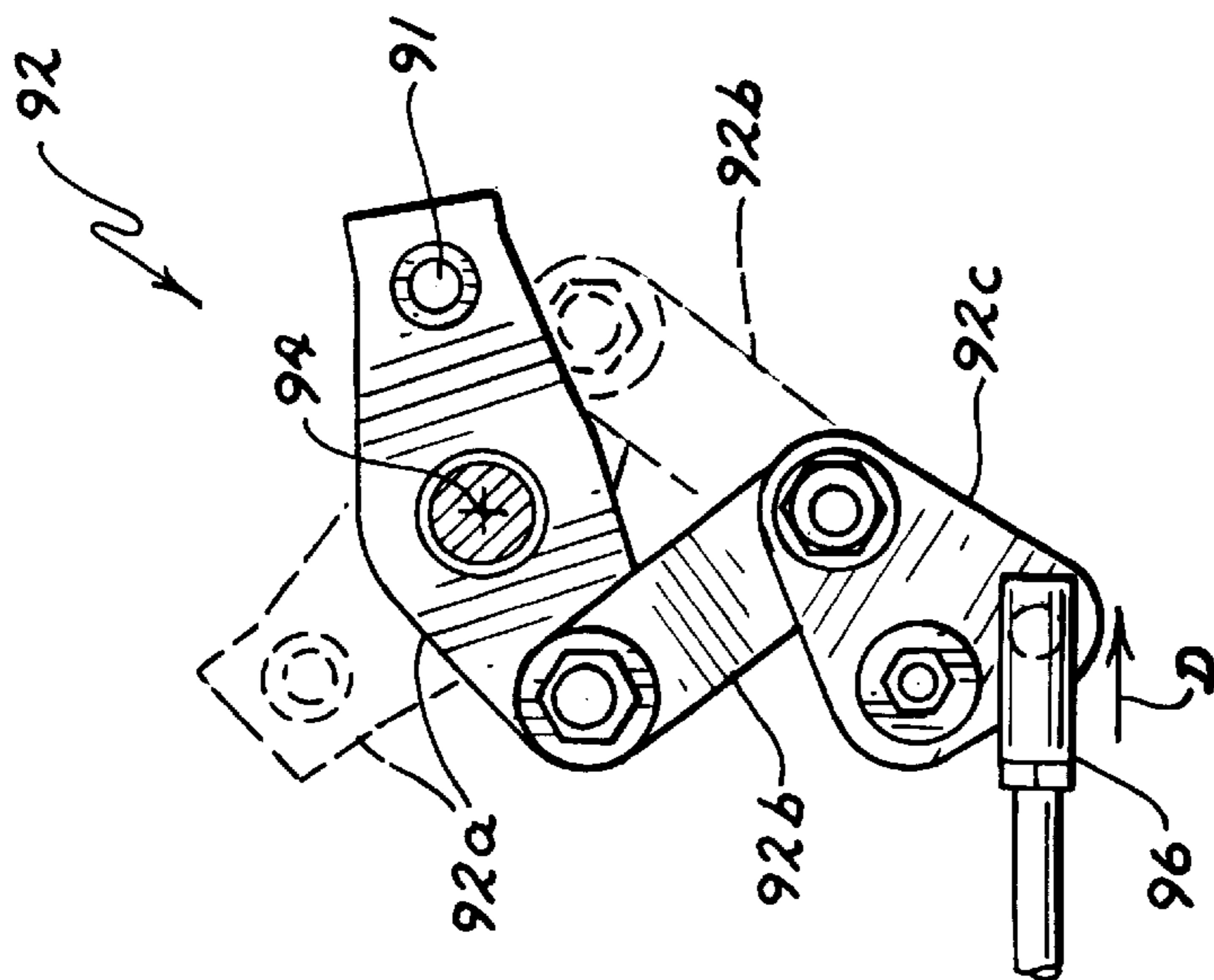


FIG. 8

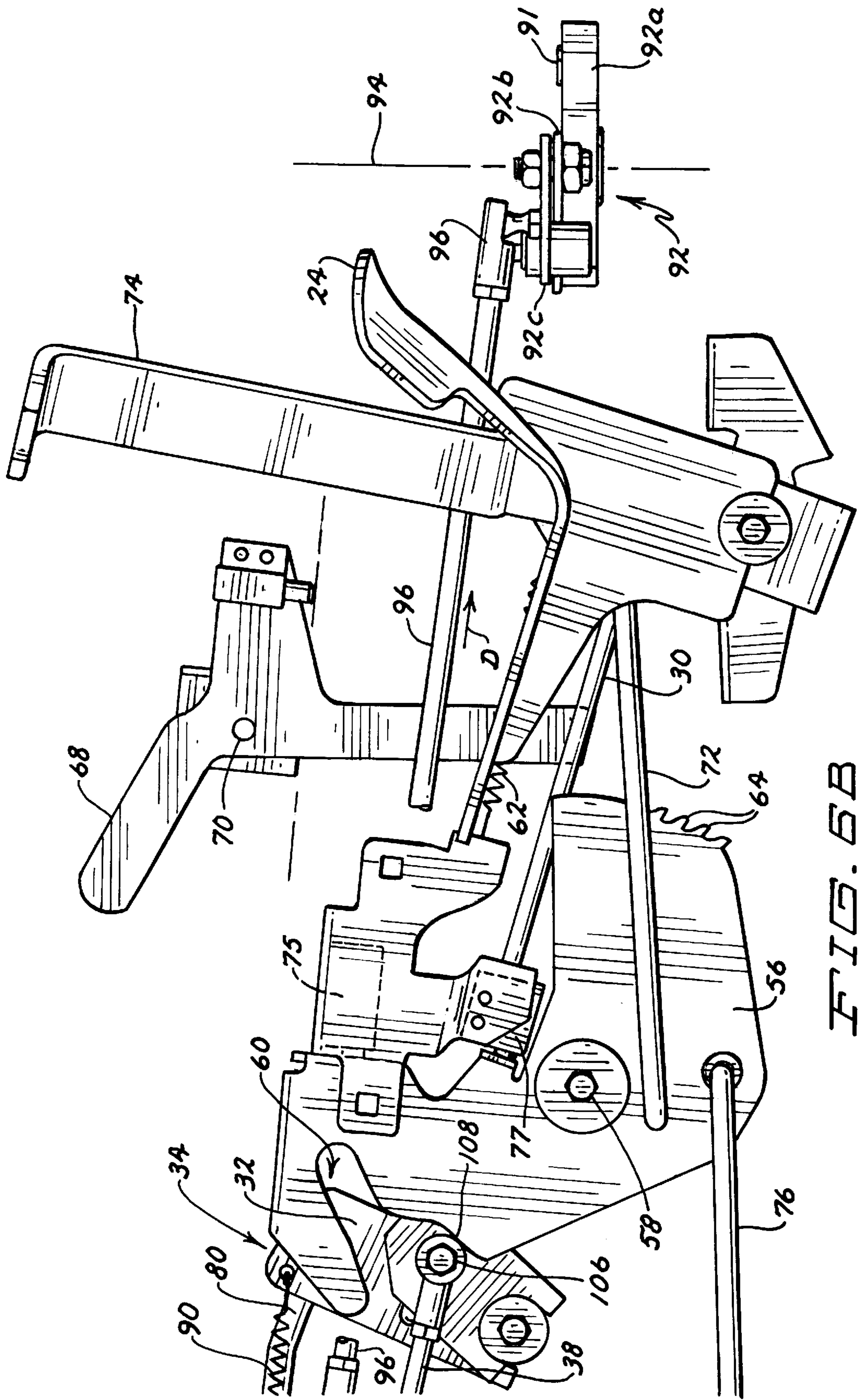


FIG. 6B

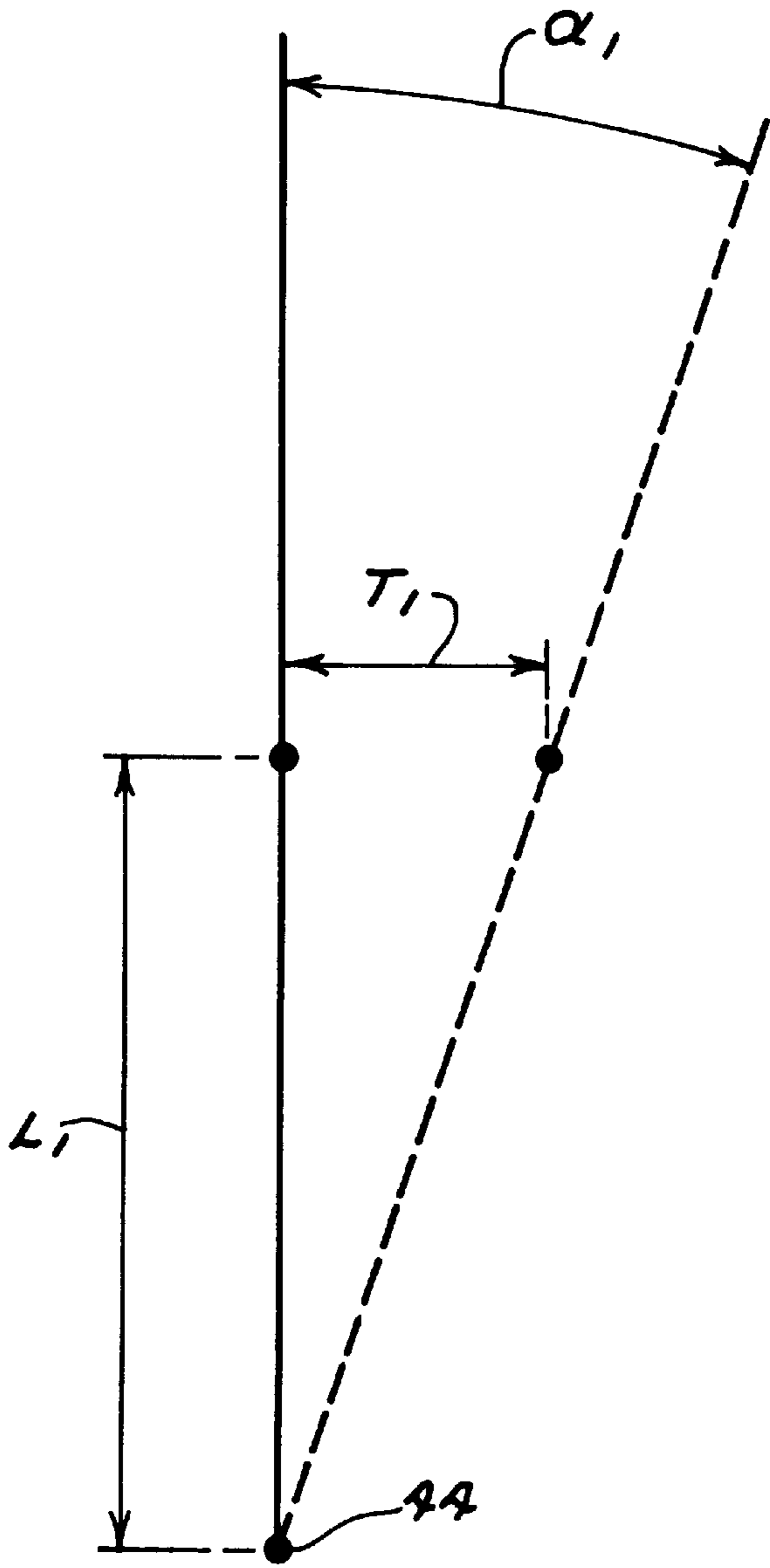


FIG. 8

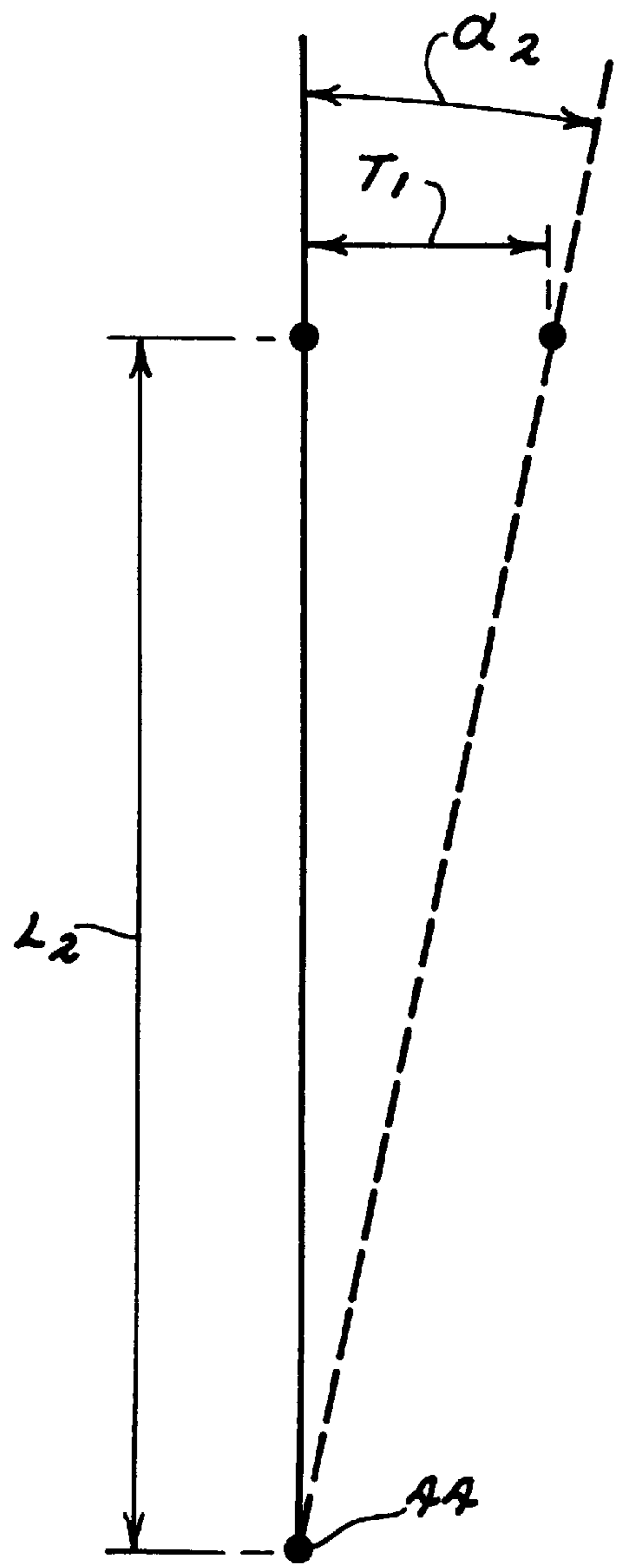


FIG. 9

CRUISE CONTROL SYSTEM FOR A VEHICLE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a division of application Ser. No. 09/024,172, filed Feb. 17, 1998.

TECHNICAL FIELD

This invention relates to a vehicle cruise control system utilizing a locking electromagnet. The cruise control system of this invention permits the operator to temporarily speed up without losing the current cruise control setting.

BACKGROUND OF THE INVENTION

Lawn and garden tractors, riding lawn mowers, and the like are vehicles that carry a seated operator. These vehicles have a speed changing system controlled by the position of an accelerator for varying the ground speed of the vehicle. Typically, the accelerator comprises a foot pedal that is biased into a neutral position. To set the vehicle speed, the operator pushes down on the foot pedal until the pedal reaches a desired position and then holds the pedal with his foot against the spring force trying to return the pedal to neutral. The need to keep the pedal depressed can be tiring when the vehicle is being driven long distances at a constant speed, i.e. from one location to another or while mowing a large area of turf.

Accordingly, vehicles of this type have been equipped with various types of cruise control systems to allow the operator to maintain the vehicle speed at a set speed without having to manually keep the accelerator depressed. One such known cruise control system is a wholly mechanical system as disclosed in U.S. Pat. No. 4,620,575 to Cuba et al., which is assigned to the assignee of this invention. In this mechanical system, a pivotal cruise control lever can be set in a desired position to engage against a pin carried on the accelerator to prevent the accelerator from returning to neutral, thereby setting a cruise control speed as determined by the position of the cruise control lever. The cruise control lever can be maintained in different selected positions by engaging a tab on the lever with one of a plurality of serrations carried on the frame of the vehicle. The operator can temporarily speed up without losing the current cruise control setting since movement of the pin on the accelerator away from the cruise control lever is allowed. The cruise control lever simply forms an abutment which prevents the accelerator from returning all the way to neutral.

Electromagnetic cruise control systems are also known in vehicles of this type which use an electromagnet to lock the accelerator linkage in place to set a cruise control speed. However, such systems do not allow the operator to easily speed up from the cruise control speed. The operator can force the accelerator linkage further forwardly from the current cruise control setting if enough force is applied to the accelerator pedal, but this loses or destroys the current cruise control setting. If the cruise control is first disengaged before speed up is attempted, it is easier to manipulate the accelerator linkage, but the cruise control setting is again lost and must be subsequently reset. U.S. Pat. No. 5,168,970 to Hough et al. shows such an electromagnetic cruise control system. Unlike mechanical cruise control systems of the type shown in the Cuba patent referred to above, there are no known electromagnetic cruise control systems which permit a temporary speed up while retaining the current cruise control setting.

SUMMARY OF THE INVENTION

It is one aspect of this invention to provide a cruise control system for a vehicle. This system comprises a selectively energizable electromagnet which when energized establishes a minimum vehicle speed setting. A means is also provided for temporarily increasing the vehicle speed above the minimum vehicle speed setting without losing or having to reset the minimum vehicle speed setting provided by the electromagnet.

It is another aspect of this invention to provide a cruise control system for a vehicle having an accelerator linkage that moves to select a forward speed of movement of the vehicle. The cruise control system comprises a cruise control link arm. A selectively energizable electromagnet holds the cruise control link arm in a fixed position. A means is provided for operatively connecting the cruise control link arm to the accelerator linkage such that the cruise control link arm when in its fixed position has a portion which abuts against a portion of the accelerator linkage to prevent the accelerator linkage from returning to neutral if released to thereby lock in a particular forward speed of movement of the vehicle as a cruise control speed. The connecting means between the cruise control link arm and the accelerator linkage is further configured to allow additional forward motion of the accelerator linkage to temporarily speed up from the cruise control speed set by the fixed position of the cruise control link arm.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be described more completely in the following Detailed Description, when taken in conjunction with the following drawings, in which like reference numerals refer to like elements throughout.

FIG. 1 is a side elevational view of a vehicle comprising a lawn and garden tractor having a slow in turn system and a cruise control system shown in solid lines with the remainder of the vehicle being shown in phantom;

FIG. 2 is a side elevational view of the slow in turn and cruise control systems of FIG. 1, showing the slow in turn system in a neutral condition with the vehicle at rest and the vehicle brakes applied, with FIG. 2 being split into two halves labelled FIGS. 2A and 2B with such halves being placed on separate sheets to allow the components of the system to be shown more clearly;

FIG. 3 is a top plan view of a portion of a cruise control system according to this invention that is operatively linked to the slow in turn system of FIG. 1;

FIG. 4 is a side elevational view of the slow in turn and cruise control systems of FIG. 1, showing the slow in turn system in a drive condition with the vehicle travelling straight at full forward speed, with FIG. 4 being split into two halves labelled FIGS. 4A and 4B with such halves being placed on separate sheets to allow the components of the system to be shown more clearly;

FIG. 5 is a top plan view of a steering linkage when the vehicle is travelling straight;

FIG. 6 is a side elevational view of the slow in turn and cruise control systems of FIG. 1, showing the slow in turn system in a drive condition with the vehicle turning at a reduced forward speed, with FIG. 6 being split into two halves labelled FIGS. 6A and 6B with such halves being placed on separate sheets to allow the components of the system to be shown more clearly;

FIG. 7 is a top plan view of the steering linkage when the vehicle is turning;

FIG. 8 is a diagrammatic view (not to scale) of the operation of the slow in turn system of FIG. 1 when the vehicle is travelling straight, showing a particular angle of rotation produced by a given translation of the accelerator linkage; and

FIG. 9 is similar to FIG. 8 and is a diagrammatic view (not to scale) of the operation of the slow in turn system of FIG. 1 when the vehicle is turning, showing the smaller angle of rotation, resulting from a lengthened moment arm, which is now produced by the same amount of translation of the accelerator linkage as shown in FIG. 8.

DETAILED DESCRIPTION

A system, generally identified as 2 in FIG. 1, is provided for automatically slowing a vehicle 4 as vehicle 4 turns. Vehicle 4 in FIG. 1 comprises a lawn and garden tractor having a frame 6 that is supported by a plurality of wheels 8 for movement over the ground. An internal combustion engine or other power source (not shown) is carried on frame 6 beneath a cowl or hood 10. The engine powers at least certain wheels 8 so that vehicle 4 is self-propelled. An operator sits on a seat 12 carried on frame 6 to drive vehicle 4.

Vehicle 4 includes a system 14 for steering vehicle 4 to allow the operator to control its direction of movement. Steering system 14 includes a steering wheel 16, positioned adjacent the operator's seat 12, which the operator can grip as he operates vehicle 4. Turning steering wheel 16 to the left or right will cause vehicle 4 to turn to the left or right because steering wheel 16 is operatively linked to one or more steerable wheel(s) 8 on frame 6. Turning steering wheel 16 rotates the steerable wheel(s) 8 about a substantially vertical axis to turn vehicle 4 out of a straight line path of movement.

The type of vehicle shown in FIG. 1, namely a lawn and garden tractor, typically has four ground engaging wheels 8 with the two front wheels 8_f being steerable and the two rear wheels 8_r being non-steerable traction or drive wheels. However, vehicle 4 could comprise a greensmower having a tricycle, three wheel configuration with two traction or drive wheels 8 on one end and a single steerable wheel 8 on the other end. Often, the single steerable wheel 8 in this three wheel configuration is on the rear end of vehicle 4 beneath the operator's seat 12. Thus, the precise wheel configuration of vehicle 4, including which wheel(s) 8 are steerable and which are driven, is not important to this invention. Vehicle 4 must simply have some type of steering system 14 that turns vehicle 4 when steering wheel 16 is turned by the operator.

In addition to steering system 14, vehicle 4 also includes a speed changing system 18 that varies the speed of vehicle 4 in accordance with the wishes of the operator. Again, the precise nature of speed changing system 18 is not important to this invention. For example, speed changing system 18 could comprise a system that increases or decreases the speed of the engine to vary the vehicle speed. Alternatively and preferably, however, speed changing system 18 comprises some type of variable speed transmission that allows vehicle 4 to travel at different speeds without affecting the engine speed, i.e. the engine can operate at a constant speed. In the case of vehicle 4 shown in FIG. 1, a variable speed transmission is preferably used which infinitely varies the vehicle speed as an input lever 20 on the transmission is rotated.

Vehicle 4 includes an accelerator 22 that is selectively moved by the operator to adjust the speed of vehicle 4.

Typically, and as shown in vehicle 4, accelerator 22 comprises a treadle type foot pedal 24 that is depressed by the foot of the operator. When the operator depresses the top of foot pedal 24 with the toes of his foot, vehicle 4 accelerates forwardly. If the operator depresses the rear or bottom of foot pedal 24 with the heel or toes of his foot, vehicle 4 accelerates rearwardly. Foot pedal 24 has a neutral position, which corresponds to a neutral position of input lever 20 on the variable speed transmission, in which vehicle 4 is stationary, i.e. vehicle 4 is not being driven either forwardly or rearwardly.

The treadle type of foot pedal 24 in which the operator uses either the toes or heel of his foot to depress one end or the other of the pedal to select forward or reverse is well known in lawn and garden tractors and similar vehicles and need not be described further herein. However, foot pedal 24 need not be a treadle type and could comprise a pedal 24 which is depressed only in one direction using the toes of one's foot. In this case, forward or reverse would be selected by some other control, such as a hand operated lever (not shown), that the operator would set to engage the transmission in a forward or reverse direction. Moreover, accelerator 22 could be something other than a foot pedal 24 and could comprise a hand operated control if so desired. Thus, the precise types of speed changing system 18 and accelerator 22 that are used on vehicle 4 could obviously be varied.

A novel and unique system 2 is provided for automatically slowing vehicle 4 during turns. As such, system 2 is most useful for a vehicle 4, such as the lawn and garden tractor that is shown in the drawings, that frequently turns. The slowing provided by the system 2 prevents scuffing of the turf and helps the operator to trim around bushes and trees. The system 2 provides slowing in both forward and reverse directions.

In addition, the system 2 works in conjunction with a novel electromagnetic cruise control system such that the automatic slowing provided by system 2 does not trip out or disengage the cruise control system. Thus, operator productivity is enhanced. The operator does not have to continually reset the cruise control system after the slowing effected during a turn has been completed and the vehicle speeds back up when resuming straight line travel.

Besides lawn and garden tractors, other outdoor maintenance vehicles have the same operational characteristics and might also profitably use slow in turn system 2. Such other vehicles 4 include small riding mowers of the type used to cut a homeowner's yard, larger riding greens-mowers or fairway mowers of the types used to cut the greens or fairways of golf courses, riding sand trap maintenance machines used to groom the sand traps of golf courses, and small utility vehicles used to transport personnel and equipment. Besides these vehicles 4, however, slow in turn system 2 could be used on any vehicle 4 of any type in which vehicle 4 is desirably slowed as vehicle 4 turns. Thus, the term "vehicle" is not meant to be limiting as to the type of vehicle involved as this invention has wide application to vehicles generally, though many vehicles with which it is most naturally used comprise outdoor maintenance vehicles.

Referring now to FIG. 2, slow in turn system 2 will be described in conjunction with sufficient other components of vehicle 4 to illustrate the structure and function of system 2.

Foot pedal 24 pivots about an accelerator pivot axis 26 on frame 6. In FIG. 2B, foot pedal 24 is shown in its neutral position in which vehicle 4 is at rest. In this position, the operator has not depressed foot pedal 24 with his foot and the vehicle's brakes (both the service and parking brakes)

are applied. FIG. 4B illustrates foot pedal 24 having been depressed by the toes of the operator's foot to drive vehicle 4 forwardly. Thus, referring to FIG. 4B and comparing it to FIG. 2B, foot pedal 24 has been rotated about accelerator pivot axis 26 in a clockwise direction indicated by the arrow A.

An accelerator linkage 28 couples foot pedal 24 to input lever 20 of speed changing system 18 so that rotation of foot pedal 24 also rotates input lever 20. Accelerator linkage 28 comprises the following components:

- 1.) a front accelerator link arm 30 extending between foot pedal 24 and a first intermediate link 32 in an intermediate link assembly 34 that is pivotal about an intermediate link assembly pivot axis 36 on frame 6;
- 2.) a rear accelerator link arm 38 extending between a second intermediate link 40 in intermediate link assembly 34 and a pivotal cam plate 42 that pivots about a cam plate pivot axis 44, rear accelerator link arm 38 not being directly coupled to cam plate 42 but being attached to a vertically movable slide 46 carried on cam plate 42; and
- 3.) a cam slot 48 in one side of cam plate 42 away from slide 46 with cam slot 48 receiving one end of input lever 20 therein.

Slide 46 has two elongated slots 50 parallel to the length thereof with these slots 50 being set one above the other. The lower slot 50l receives the pin that forms cam plate pivot axis 44. The upper slot 50u receives an upper pin 52 extending between cam plate 42 and slide 46. This upper pin 52 forms a connection between slide 46 and cam plate 42 which rotates cam plate 42 when slide 46 rotates. For example, if slide 46 were to rotate in a clockwise direction about cam plate pivot axis 44, then the upper slot 50u in slide 46 would push against the upper pin 52 to also conjointly rotate cam plate 42 about cam plate pivot axis 44.

Accordingly, when the operator steps down on foot pedal 24 to drive vehicle 4 forwardly, the clockwise rotation of foot pedal 24 represented by the arrow A in FIG. 4B pulls on front accelerator link arm 30, which in turn rotates intermediate link assembly 34 about intermediate link assembly pivot axis 36, which in turn pulls on rear accelerator link arm 38. As rear accelerator link arm 38 is pulled forwardly in the direction of the arrow B in FIG. 4A, slide 46 is rotated clockwise about cam plate pivot axis 44 as represented by the arrow C in FIG. 4A. This in turn causes cam plate 42 to rotate clockwise because of the interaction between upper pin 52 on cam plate 42 and upper slot 50u. As cam plate 42 rotates in a clockwise direction, cam slot 48 on the other side of cam plate 42 will rotate input lever 20 on speed changing system 18 in a clockwise direction. The net result of all this is that rotation of foot pedal 24 in a clockwise or forward direction effects a clockwise or forward rotation of input lever 20 on speed changing system 18 to select a particular forward speed of movement for vehicle 4.

The degree of rotation of foot pedal 24 determines how fast vehicle 4 travels. The farther the operator pushes down on foot pedal 24, the farther cam plate 42 and input lever 20 on speed changing system 18 are rotated. Thus, FIG. 4 illustrates speed changing system 18 at its maximum forward speed with foot pedal 24 having been fully depressed in its forward direction and the end of input lever 20 having reached the top of cam slot 48. Pushing down on foot pedal 24 only partway would result in a forward speed set somewhere between zero and its maximum forward speed.

As can be seen from FIG. 2A, cam slot 48 also has a lower section 49 that extends below the end of input lever 20 when system 2 is in its neutral position. This lower section 49 of

cam slot 48 is to accommodate movement of foot pedal 24 in its reverse direction, i.e. when the operator depresses the lower end of foot pedal 24 with the heel or toes of his foot to rotate foot pedal 24 in a counterclockwise direction in FIG. 2B. When this happens, accelerator linkage 28 described above will rotate and move reversely to that described so as to rotate input lever 20 in a counterclockwise direction to set a reverse speed. However, the orientation of the components of system 2 in reverse has not been illustrated in the drawings.

A return to neutral system sets foot pedal 24 and speed changing system 18 in their neutral orientation of FIG. 2 whenever the operator's foot is off foot pedal 24. This return to neutral system includes a pivotal, return to neutral lever 51 that rotates about a return to neutral pivot axis 53. The free end of the return to neutral lever 51 includes a pin or bushing 55 that rides against one side of cam plate 42. Bushing 55 rests in a notch 43 on cam plate 42 when the foot pedal 24 and speed changing system 18 are in their neutral positions. A spring 57 exerts a counter-clockwise torque on lever 51 tending to bias lever 51 in the direction required to seat bushing 55 in notch 43. See FIG. 6A. This type of return to neutral system comprising a pivotal, spring biased return to neutral lever is known in the art for setting a variable speed transmission in neutral.

Accelerator linkage 28 interacts with a brake system 54 that also sets foot pedal 24 and speed changing system 18 in their neutral orientation of FIG. 2 whenever the operator's foot is off foot pedal 24 and the vehicle's brakes have been applied. This brake system 54 includes a pivotal, brake bellcrank 56 that rotates about a brake pivot axis 58. Brake bellcrank 56 includes a slot 60 on its rear arm that engages against a post (not shown) on intermediate link assembly 34 which is connected to one end of rear link arm 38. Whenever foot pedal 24 is not depressed in either the forward or reverse directions and brake pedal 74 is depressed, slot 60 in the rear arm of brake bellcrank 56 forces accelerator linkage 28, and hence input lever 20 on speed changing system 18, into their neutral orientation of FIG. 2.

The front arm of brake bellcrank 56 is provided with a plurality of sawteeth 64. When brake pedal 74 is first depressed to actuate the vehicle's brakes and place brake bellcrank 56 in the position shown in FIG. 2, these sawteeth 64 are then in a position to cooperate with a lower locking edge 66 on a parking brake 68. As shown in FIG. 2, parking brake 68 can then be set such that its locking edge 66 is engaged with one of sawteeth 64. Accelerator linkage 28 is then locked to prevent inadvertent actuation of foot pedal 24. The operator must release parking brake 68, either by pivoting it about a parking brake pivot axis 70 to disengage parking brake 68 or by stepping on brake pedal 74 for the vehicle's service brakes which also releases parking brake 68, before vehicle 4 can be driven.

Brake bellcrank 56 is mechanically linked by a front brake link arm 72 to a brake pedal 74 that may be selectively operated to stop vehicle 4. A brake return spring 62 normally positions brake pedal and brake bellcrank 56 in their unactuated positions shown in FIG. 4B. A rear brake link arm 76 extends from brake bellcrank 56 to the braking system (not shown) of vehicle 4. As described above, whenever the operator engages his foot with the top of brake pedal 74 and pushes down on brake pedal 74, brake bellcrank 56 would also be rotated in the direction that would reset accelerator linkage 28 and input lever 20 on speed changing system 18 to neutral. This is a further safety feature which is often used in vehicles of this type. In other words, in other lawn and garden tractors known prior to this invention, stepping on the brake pedal often resets accelerator linkage 28 to neutral.

A cruise control system 78 according to this invention is provided for temporarily locking accelerator linkage 28 in a selected position. Cruise control system 78 comprises a cruise control link arm 80 having one end received in a substantially horizontal slot 82 in the top of first link 32 of intermediate link assembly 34 in accelerator linkage 28. The other end of cruise control link arm 80 includes a horizontal locking plate 84 that pivots about a substantially vertical, cruise control pivot axis 86. An electromagnet 88 underlies plate 84.

A biasing spring 90 extends between cruise control link arm 80 and first link 32 of intermediate link assembly 34. This biasing spring 90 keeps cruise control link arm 80 forced up against the forward end of horizontal slot 82. As intermediate link assembly 34 pivots in a clockwise direction, spring 90 will be tensioned thus biasing cruise control link arm 80 forwardly in slot 82 as well to remain engaged with the forward end of slot 82.

After the operator has selected a desired speed of travel by depressing foot pedal 24 a desired amount, he can lock accelerator linkage 28 in place by pressing a cruise control set button (not shown) adjacent the operator's seat or on the vehicle's dash or in some other location convenient to the operator. When this is done, electromagnet 88 is energized to lock accelerator linkage 28 in a desired spot by attracting and holding horizontal locking plate 84 using an electromagnetic force. Thus, if the operator removes his foot from foot pedal 24 and cruise control system 78 is engaged, accelerator linkage 28 will stay in place as cruise control link arm 80 will prevent accelerator linkage 28 from returning to neutral.

In this cruise control system, depression of brake pedal 74 will be sensed by a sensor 75 and cruise control system 78 will automatically be disengaged by deenergizing electromagnet 88 to release cruise control link arm 80. Thus, tapping or stepping on the brakes will automatically release cruise control system 78. Another sensor 77 enables the operator to start the engine of vehicle 4 only when the speed changing system 18 is locked in its neutral position.

Horizontal slot 82 in cruise control system 78 is elongated to allow the operator to temporarily speed up from the current cruise control setting without having to subsequently reset cruise control system 78. The operator can depress foot pedal 24 and move accelerator linkage 28 to a position farther forward than the position at which accelerator linkage 28 is locked when foot pedal 24 is at less than its full speed position. This movement is allowed due to the elongation of horizontal slot 82. Once the temporary overspeeding condition is ended and the operator takes his foot off foot pedal 24, accelerator linkage 28 will reset to that position determined by cruise control system 78, i.e. where the forward end of horizontal slot 82 in first link 32 of intermediate link assembly 34 engages against the front end of cruise control link arm 80.

Elongated slot 82 also prevents the cruise control system from being effective during reverse motion of vehicle 4. During reverse motion, first link 32 will move rearwardly as required to obtain reverse motion with the front end of slot 82 pushing the cruise control link arm 80 rearwardly. If the cruise control system is then set to energize electromagnet 88, electromagnet 88 will attract and grab locking plate 84 to lock cruise control link arm 80 in place. However, if the operator were to release foot pedal 24 to end the reverse motion of vehicle 4, the locked cruise control link arm 80 does not prevent the accelerator linkage from resetting to neutral. The elongation in slot 82 allows first link 32 to move forwardly relative to the front end of cruise control link arm

80 as spring 90 is weaker than the spring acting on the return to neutral lever 51. Thus, the accelerator linkage will reset from a position for obtaining reverse motion of vehicle 4 to its neutral position even if the cruise control system has been engaged. Cruise control is simply not effective in reverse due to the elongation of slot 82.

The cruise control system embodied herein is electrically actuated, i.e. by energizing electromagnet 88, but still permits the operator to speed up when going in a forward direction while retaining the cruise control setting. The energization of electromagnet 88 locks cruise control link arm 80 in place, but the accelerator linkage is forwardly movable relative to link arm 80 due to elongation of slot 82. When the operator releases pedal 24, the accelerator linkage returns towards neutral until the front end of slot 82 reengages against the front of cruise control link arm 80. The electromagnet 88 remains continuously energized. Thus, the operator need not reset the cruise control link arm 80 each time he or she speeds up, which is a further productivity enhancement and eases the task of driving vehicle 4. In electromagnetic cruise control systems known in the prior art, the only way to obtain an increase in speed from an existing cruise control setting was to physically force the locking plate past the electromagnet to a new position, thus losing the existing cruise control setting in the process. Accordingly, the cruise control system disclosed herein has usefulness separate and apart from the slow in turn system 2.

The automatic slow in turn system 2 further includes a connecting linkage between steering system 14 of vehicle 4 and slide 46 that is part of accelerator linkage 28. More particularly, the use of the elongated slots 50 in slide 46 allows slide 46 to rise or lift upwardly relative to cam plate axis 44. This movement of slide 46 is accomplished as vehicle 4 turns. This movement of slide 46 effectively changes the geometry in accelerator linkage 28 to decrease the amount cam plate 42 rotates for a given elongation of accelerator linkage 28. Thus, as slide 46 rises, the amount of rotation of cam plate 42 decreases, and vehicle 4 automatically slows as it turns.

The connecting linkage to steering system 14 includes a set of horizontal connecting links 92a, 92b and 92c that are coupled to steering system 14. As the user rotates steering wheel 16, first connecting link 92a also rotates about a substantially vertical axis 94 to rotate the remaining links 92b and 92c. FIG. 5 shows the orientation of connecting links 92 when vehicle 4 is traveling straight ahead. FIG. 7 shows the orientation of connecting links 92 during a turn with the solid line illustration representing a left turn of vehicle 4 and the phantom line illustration representing a right turn of vehicle 4.

Any suitable connection may be made between steering system 14 and link 92a. For example, link 92a may be provided with an opening 91 for connecting to the arm of a power steering cylinder such that the cylinder arm rotates link 92a as it moves in response to movement of steering wheel 16 by the operator. Alternatively, link 92a may be rotated by a gear in a steering system not having a power steering cylinder which gear is rotated when the operator turns steering wheel 16. The exact connection between steering system 14 and link 92a is not important to this invention and, therefore, has not been specifically illustrated herein.

Connecting links 92 shown in FIG. 5 are designed to pull on a slow in turn link arm 96 whether vehicle 4 is turning to the right or the left. Note that in a turn, the front end of slow in turn link arm 96 gets moved forwardly on vehicle 4 (to the

right in FIG. 7) regardless of the direction of the turn. Compare FIG. 7 to FIG. 5. The front end of slow in turn link arm 96 is moved forwardly on vehicle 4 (to the right in FIG. 7) in either a right turn or a left turn of vehicle 4.

Slow in turn link arm 96 is connected to a slow in turn bellcrank 98 that pivots about a substantially horizontal pivot axis 100. The rear arm of slow in turn bellcrank 98 has an arcuate slot 102 that receives a pin 104 carried on the lower end of slide 46. Preferably, pin 104 is formed by a bushing having ball bearings to smoothly roll against the edges of slot 102, though this is not necessary. The inter-connection of pin 104 with arcuate slot 102 is what lifts slide 46 during a vehicle turn.

When the operator uses steering wheel 16 to turn vehicle 4, whether to the left or right, connecting links 92 shown in FIG. 5 pull link arm 96 forwardly as represented by the arrow D in FIGS. 6B and 7. This in turn rotates slow in turn bellcrank 98 in a clockwise direction about its pivot axis 100 as represented by the arrow E. This causes the rear arm of slow in turn bellcrank 98 that is engaged with slide 46 to rise, thereby forcing the entire slide upwardly. Compare FIG. 4 where no rise of slide 46 has occurred to FIG. 6 where some rise has occurred due to a turn of vehicle 4. In fact, the FIG. 6 orientation represents slide 46 having been vertically raised the maximum amount since cam plate pivot axis 44 and upper pin 52 have moved from one end to the other of vertical slots 50 in slide 46.

The amount slide 46 is raised is proportionate to the amount steering wheel 16 is turned. Preferably, the parts are configured so that slide 46 is raised to its maximum extent when vehicle 4 is in a maximum turn. In lesser turns, slide 46 will still be raised proportionately, but cam plate pivot axis 44 and upper pin 52 will not reach the lower end of the vertical slots 50 as they will in a maximum turn.

The effect of lifting slide 46 is to change the length of the moment arm between cam plate pivot axis 44 and the point of connection of rear accelerator link arm 38. Referring to FIG. 8, when vehicle 4 is traveling straight without turning, slide 46 is in its lowermost position on cam plate 42. In this orientation of slide 46, the moment arm has a length diagrammatically shown as L_1 in FIG. 8. Thus, when the operator depresses foot pedal 24 a desired amount to cause rear accelerator link arm 38 to move forwardly a predetermined amount diagrammatically indicated as T_1 , cam plate 42 will have a predetermined amount of rotation diagrammatically indicated as α_1 in FIG. 8.

Notice what happens when vehicle 4 turns and slide 46 moves upwardly. The length of the moment arm of rear accelerator link arm 38 now increases from L_1 to L_2 . See FIG. 9 which depicts the lengthening of the moment arm. Thus, for an identical amount of forward translation T_1 of rear accelerator link arm 38, one gets a smaller amount of rotation α_2 for cam plate 42. Effectively, cam plate 42 is rotated reversely to pivot input lever 20 of speed changing system 18 rearwardly, thereby reducing the vehicle speed. This happens automatically as slide 46 rises simply by virtue of the geometry of the parts and the consequent lengthening of the moment arm between cam plate pivot axis 44 and the point of attachment of rear accelerator link arm 38. Slide 46 simply forms a slidable connection point between cam plate 42 and rear accelerator link arm 38.

Slow in turn system 2 has been described as using bellcrank 98 to lift or raise slide 46 during a vehicle turn. However, system 2 is geometrically configured so that slide 46 would normally lift on its own accord due to the forward pull from the accelerator linkage as the operator depresses foot pedal 24. Thus, bellcrank 98 normally prevents or

blocks slide 46 from moving up when vehicle 4 is travelling straight, but permits slide 46 to rise when vehicle 4 is turning. In any case, whether the parts are configured such that bellcrank 98 physically lifts slide 46 during a turn, or permits slide 46 to rise during a turn from some other force such as that provided by accelerator linkage pull, is irrelevant. The important point is that slide 46 is vertically movable relative to cam plate pivot axis 44 and does in fact move away therefrom during a vehicle turn to change the system geometry as described earlier.

As slide 46 rises during a vehicle turn, the connection point between slide 46 and rear accelerator link arm 38 will also move up. Compare FIG. 4A with FIG. 6A. The components of slow in turn system 2 are configured so that this motion of the connection point of rear accelerator link arm 38 to slide 46 will lie on the circle whose origin is the front connection point where rear accelerator link arm 38 connects to second link 40 of intermediate link assembly 34. Since the front connection point of rear accelerator link arm 38 to intermediate link assembly 34 is pivotal, all that happens to accelerator linkage 28 during a vehicle turn is that rear accelerator link arm 38 pivots in a clockwise direction about the front connection point while cam plate 42 and slide 46 move rearwardly. Intermediate link assembly 34 and front accelerator link arm 30, along with cruise control link arm 80, remain absolutely stationary for a given position of foot pedal 24.

As a result, slow in turn system 2 operates to automatically slow vehicle 4 during turns without affecting the position of foot pedal 24 or cruise control system 78. Using the example noted above, for a given depression of foot pedal 24 and for a corresponding given amount of forward translation of accelerator linkage 28, i.e. for a given amount of T_1 , the rise in slide 46 will slow vehicle 4 by rotating slide 46 and cam plate 42 reversely about cam plate pivot axis 44 without in any way affecting the position of either foot pedal 24 or cruise control system 78 if it is engaged. Thus, vehicle 4 slows, but foot pedal 24 is not forced back against the operator's foot as in prior systems and cruise control system 78 does not disengage or need not be disengaged.

The advantages of this are apparent. Slow in turn system 2 operates without forcing foot pedal 24 back. This avoids distracting the operator. Moreover, this is done with a mechanical linkage system that is durable, simple and operates reliably. Slow in turn system 2 operates without electrical power or sensors of any type and depends just on the mechanical geometry of its parts. It works without any conscious operator intervention.

One tendency an operator might have in a vehicle equipped with this slow in turn system is to push down on foot pedal 24 harder as vehicle 4 slows in a turn to attempt to keep the pedal pressure sensed by the operator against his or her foot constant. If additional forward movement of pedal 24 were permitted during a turn from the pedal position occurring before the turn began, then the operator could manually accelerate vehicle 4 to override the action of the slow in turn system 2. This is permitted by system 2 in certain situations but not in other situations.

Consider that a vehicle 4 of this type desirably has a maximum straight ahead speed. In this case, vehicle 4 preferably has a maximum straight ahead speed of 7 miles per hour (mph) or so. However, at any given time, vehicle 4 might be travelling straight at speeds, e.g. 2 or 3 mph, much less than the maximum straight ahead speed. In fact, because of the infinitely variable speed permitted by the transmission, the operator might select any straight ahead speed in the range of 0 to the maximum permitted speed, i.e. anywhere from 0 to 7 mph in the example used above.

A particular straight ahead speed is selected, of course, by depressing and holding foot pedal **24** at a particular position. This, in turn, is done by most operators by sensing the pressure of the pedal against his or her foot when the pedal is in the desired position. The operator then tries to keep this pressure constant so as to maintain a constant position of the foot pedal.

If the operator has selected a position for foot pedal **24** that sets a relatively slow straight ahead speed, say 3 mph, and then initiates a turn, slow in turn system **2** will automatically reduce the already slow speed of vehicle **4**. This can be a disadvantage in certain operational situations. For example, if the operator is driving vehicle **4** slowly up a hill and then turns vehicle **4** while climbing, the reduction in speed brought about by slow in turn system **2** could be sufficient to cause vehicle **4** to stop. In this situation, it is desirable to allow the operator to press further down on foot pedal **24** to at least overcome the speed reduction caused by slow in turn system **2** to thereby continue the slow speed ascent of vehicle **4** up the hill. Moreover, since many of the problems overcome by system **2**, such as preventing turf scuffing, are not as prevalent at low speeds of vehicle **4**, allowing operator **2** to manually override the effect of system **2** during turns at lower speeds is permissible. Accordingly, slow in turn system **2** is designed to do precisely that, i.e. operator **2** may push down further on foot pedal **24** during low speed turns of vehicle **4** to manually accelerate vehicle **2** out of the even lower speed that would otherwise have been provided by the action of slow in turn system **2**.

However, the same rationale does not apply to operation of system **2** during turns at higher vehicle speeds close to the maximum speed of vehicle **4**. In such a situation, turf scuffing is much more likely to occur. Thus, allowing the operator to override the speed reduction provided by slow in turn system **2** is not desirable at higher vehicle speeds.

Accordingly, in this system **2**, rear accelerator link arm **38** connects to intermediate link assembly **34** at the front connection point using a bolt or pin **106** that faces a rearwardly facing abutment. Conveniently, this abutment is formed by a rearwardly facing surface **108** on brake bellcrank **56**. This surface **108** is deliberately shaped to abut against bolt or pin **106** at certain times to prevent the operator from achieving any additional forward depression of foot pedal **24**.

The interaction between bolt or pin **106** and surface **108** can best be explained by referring to FIGS. **4B** and **6B**. In FIG. **4B**, the vehicle is traveling straight at its maximum straight ahead speed, preferably 7 mph, and pin **106** abuts against surface **108**. If the operator initiates any type of turn up to the maximum turn shown in FIG. **6B**, a progressive speed reduction occurs from 7 mph to the speed permitted during a maximum turn (i.e. a turn in which steering wheel **16** is full over) which is desirably about 4 mph. In these turning situations after initially travelling straight at the maximum straight ahead speed, pin **106** remains in abutting engagement with surface **108** to prevent the operator from further accelerating vehicle **4**.

However, at straight ahead speeds lower than the maximum straight ahead speed, there is normally some distance between pin **106** and surface **108** which distance varies with the straight ahead speed of vehicle **4**. The lower the straight ahead speed at which vehicle **4** is travelling, the greater the distance between pin **106** and surface **108**. Thus, in these conditions, during a turn, the operator can still push down on foot pedal **24** to advance the accelerator linkage at least until the pin **106** engages against surface **108**. Thus, during turns at lower straight ahead speeds, the operator can accelerate

vehicle **4** up to the speed that would have been permitted during a turn of similar angle while at the maximum straight ahead speed, whatever that speed might be. This assumes, of course, that the cruise control system is either off or is set sufficiently high so that pin **106** engages against surface **108** before the front end of cruise control link arm **80** engages the rear side of slot **82**.

For example, when travelling at the maximum straight ahead speed of 7 mph as shown in FIG. **4B**, if the operator initiates a maximum turn as shown in FIG. **6B**, the speed provided by system **2** drops to 4 mph as described earlier. However, if the vehicle had initially been travelling at a straight ahead speed of only 3 mph instead of 7 mph, there would have been some distance between the pin **106** and surface **108**. Thus, if the operator had then initiated a maximum turn, the operator could have, if he or she had so desired, simply pushed down on foot pedal **24** to keep the vehicle speed at or around 3 mph. This foot pedal depression would have brought pin **106** closer to surface **108**, but there would still have been some distance between the two as long as only 3 mph was maintained by the operator. In fact, if the operator had so desired, the operator could have pushed down on foot pedal **24** to accelerate the vehicle past 3 mph all the way back to 4 mph (the speed of vehicle **4** in a maximum turn when initially travelling at the maximum straight ahead speed) at which point the pin **106** would have reengaged the surface **108**. Thus, pin **106**, which simply forms a convenient stop or tab on accelerator linkage **28**, and its engagement with surface **108** prevents any acceleration of the vehicle past 4 mph in a maximum turn regardless of the initial straight ahead speed of vehicle **4**.

Various modifications will be apparent to those skilled in the art. For example, accelerator linkage **28** is split into two link arms, namely front accelerator link arm **30** and rear accelerator link arm **38**, primarily for two reasons. First, it is easier to link foot pedal **24** to cam plate **42** using two separate link arms in the crowded confines of slow in turn system **2** given where the other components are placed. Secondly, the rear connection point of rear link arm **38** has to move on the circle whose origin is the front connection point of the link arm **38** during turns of vehicle **4** if the operation of slow in turn system **2** is to avoid moving foot pedal **24** rearwardly. This is easier to accomplish with a shorter second link arm **38** rather than with a longer single link arm. However, having said the above, it would be possible to use only a single link arm to connect foot pedal **24** to slide **46** on cam plate **42** in place of the two link arms **30** and **38** that are shown.

Moreover, the connection point between the rear link arm and cam plate **42** could be something other than the vertically movable slide **46**. For example, slide **46** could be dispensed with and a vertical slot could be placed in cam plate **42** extending away from cam plate pivot axis **44**. The connection point of rear link arm **38** could then be placed within this slot so that the rear connection point of rear link arm **38** would slide up and down in this slot in cam plate **42**. The rear arm of slow in turn bellcrank **98** lever would then somehow engage against the rear link arm to move it upwardly in the slot as vehicle **4** turns.

It would also be possible to connect slider **46** directly to the speed control lever **20** of the transmission without using a separate cam plate **42**. Cam plate **42** is useful with some transmissions which are too sensitive to direct motion of speed control lever **20** with cam plate **42** dampening or reducing the affect that motion of slider **46** has on speed control lever **20**. However, this dampening aspect of cam plate **42** may not be needed with other transmissions, and thus cam plate **42** could be dispensed with in such transmissions.

Slow in turn system **2** is configured so that vehicle **4** slows in all turns with the amount of the slowing being proportionate to the amount steering wheel **16** is turned. During a slight turn of steering wheel **16**, vehicle **4** slows only a little from its preset speed. During a maximum turn of steering wheel **16**, vehicle **4** slows more.

However, it would be possible to have a slow in turn system in which the amount of slowing was not proportionate to the amount of the turn or where turns in certain ranges would not slow vehicle **4** at all. For example, some type of lost motion connection could be used between the steering system and the connecting links **92** so that slight turns in either direction would not slow vehicle **4** at all. Slow in turn system **2** would begin to operate only when vehicle **4** is turned more than a certain number of degrees in either direction.

Accordingly, because of the many variations of this invention which will be apparent to those skilled in the art, this invention is to be limited only by the appended claims.

We Claim:

1. A cruise control system for a vehicle having an accelerator linkage that is biased towards neutral but can be moved in opposite directions against the force of the bias to select a forward or reverse speed of movement of the vehicle, respectively, which comprises:

- (a) selectively energizable electromagnetic means which when energized establishes a cruise speed setting; and
- (b) means operatively linking the electromagnetic means to the accelerator linkage such that energization of the electromagnetic means when a forward speed of movement of the vehicle has been selected by the position of the accelerator linkage is effective to establish a cruise speed setting but energization of the electromagnetic means when a reverse speed of movement of the vehicle has been selected by the position of the accelerator linkage does not establish a cruise speed setting.

2. A cruise control system for a vehicle having an accelerator linkage that is biased towards neutral but can be moved at least in one direction against the force of the bias to select at least a forward speed of movement of the vehicle, which comprises:

- (a) a cruise control link;
- (b) selectively energizable electromagnetic means for holding the cruise control link in a fixed position, the electromagnetic means comprising an electromagnet positioned adjacent a portion of the cruise control link with the electromagnet developing a force for attracting and holding the cruise control link in the fixed position with the fixed position comprising whatever position

the cruise control link occupies at the moment when the electromagnet is energized; and

(c) means for operatively connecting the cruise control link to the accelerator linkage such that the cruise control link when in its fixed position has a portion which engages against a portion of the accelerator linkage to prevent the accelerator linkage from returning to neutral if released to thereby lock in a particular forward speed of movement of the vehicle as a cruise control speed, the connecting means between the cruise control link and the accelerator linkage being further configured to allow additional forward motion of the accelerator linkage to temporarily speed up from the cruise control speed set by the fixed position of the cruise control link.

3. The cruise control system of claim **2**, in which the means for operatively connecting the cruise control link to the accelerator linkage comprises a pin received in an elongated slot.

4. The cruise control system of claim **3**, further including means for biasing the pin against one end of the slot.

5. The cruise control system of claim **4**, wherein the pin is fixed to the cruise control link and the slot is part of the accelerator linkage.

6. The cruise control system of claim **5**, wherein the slot has a forward end and a rearward end taken with respect to movement of the accelerator linkage when the accelerator linkage is biased to accelerate the vehicle in a forward direction, and wherein the biasing means keeps the pin engaged against the forward end of the slot.

7. The cruise control system of claim **2**, further including an accelerator operatively connected to the accelerator linkage which accelerator can be manually moved by the operator to cause the accelerator linkage to move.

8. The cruise control system of claim **7**, wherein the accelerator comprises a foot pedal.

9. The cruise control system of claim **2**, wherein the cruise control link comprises an elongated arm.

10. The cruise control system of claim **9**, wherein the portion of the cruise control link that is adjacent the electromagnet comprises a substantially flat plate that is carried on the elongated arm.

11. The cruise control system of claim **10**, wherein the plate is carried at one end of the elongated arm.

12. The cruise control system of claim **2**, wherein the portion of the cruise control link that is adjacent the electromagnet comprises a substantially flat plate.

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